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XIII.

ON SATURN'S RINGS.

BY L. TROUVELOT.

Presented Nov. 14th, 1877.

IN No. 2146 of the "Astronomische Nachrichten," Professor Asaph Hall, in giving the results of his observations on the planet Saturn, makes some remarks on my observations of the same planet which were published in the Proceedings of the American Academy for the year 1875-1876.

Professor Hall began his observations in June, 1875. "At first," he says, "my attention was not specially given to the appearance of the Ring. . . . After the picture of Saturn was made by Mr. L. Trouvelot with our telescope in September, 1875, I gave more attention to the appearance of the Ring, and I have done so during the last year. . . . On account of the confidence I have in the drawings made by so skilful an artist, I have been surprised to find that I have never been able to see the slightest trace of two phenomena of the Ring which Mr. Trouvelot draws with the greatest distinctness."

Here Professor Hall refers : first, to the notch which I have represented in the shadow of the globe of Saturn on the Ring ; second, to the jagged or tooth-like appearance of the principal division on the ansæ.

Had Professor Hall consulted his memory, undoubtedly his surprise would have been less ; since he would have remembered that on the same drawing to which he refers, and which I made at the Naval Observatory in his presence, I represented the shadow of the Ball with its convexity turned towards the planet, just as he saw it later and described it, and as indeed I continued to see it during 1876. Knowing that the shadow was curved inward in September and not notched, I fail to understand why he should have expected to see a notched shadow rather than a curved one, when almost a year had elapsed between his observations and mine, in December, 1874.

Besides myself, Schröter, Lassell, De La Rue, Jacob, Bond, Coolidge, Tuttle, and many others, have seen the shadow more or less notched.

From these observations, it would seem that this phenomenon is not a very rare one; but it is not permanent, as Professor Hall appears to have supposed.

I am indebted to Professor Edward S. Holden, of the Naval Observatory, for an interesting drawing and observation of Saturn, which he made with the 28-inch silvered-glass reflector of Dr. Henry Draper of New York, on the night of Sept. 8, 1874. At his request, Dr. Draper has kindly sent to me a tracing of his original drawing, accompanied with the memorandum recorded in the note-book, at the moment of the observation. It reads as follows: "Observation of Sept. 8, 1874. Division of rings seen all round; inner ring greatly brighter than outer, particularly on the outer edge of it: main belt *triple*, reddish brown in color; upper and lower edges of belt sharp. Shadow of ball, on ring, like this; *i.e.*, funnel-shaped." Fig. 1.

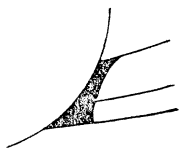


Fig. 1.

As to the jagged appearance of the outer border of the principal division, Professor Hall has seen no trace of it. He says: "The only approach to the appearance of the division as drawn by Mr. Trouvelot that I have ever seen has been when the image of the planet was tremulous, and the sky so clear as to give a distinct but unsteady view of the division of the Ring. At such times the unsteady appearance of the division might lead to some such view as that given by Mr. Trouvelot; but still I think he must have seen something quite different." After saying that, during six or eight nights in a year, their large telescope gives excellent images of Saturn, he continues: "On these nights the appearance of the planet is very beautiful; but my experience is that on these rare nights one will see fewer strange phenomena about the Ring and the shadows than when the images are blurred and indistinct."

Even if I could have been so greatly deceived as to represent for realities the deformations undergone by images in rapid vibrations, I am pretty certain that I could not have seen the delicate dark angular forms which I have represented, but rather rounded, ill-defined forms totally wanting in the blackness and sharpness of those which I saw. Contrary to Professor Hall's suggestion, it is precisely when the definition was the most perfect that the "strange phenomena" could be seen with more distinctness, and at the moment the image became tremulous in the least, it disappeared confounded with the dark division of the rings.

The fact that Professor Hall has not been able to see the "Pencil line," even during one of these beautiful nights he speaks of, sufficiently

indicates his failure to see the jagged appearances of the principal division; and indeed, he could not have expected to see it, as these forms are almost as difficult to make out as the grayish line of the outer ring.

I have no positive evidence that these markings continued visible after the end of September, 1875; as, after that time, I discontinued somewhat my observations on Saturn, looking at it only occasionally, until the present year, during which, I have observed it on every possible occasion. But, of course, the obliquity of the Ring is too great now to allow the observation of such delicate forms, although I still continue to see the principal division on the ansæ. It is not impossible that the obliquity of the Ring was the cause of the failure of Professor Hall to verify my observations, or the phenomenon may be a temporary one, and it may have been absent when he made his observations.

The phenomenon of the jagged border of the principal division, as I have represented it, was seen so often and with such distinctness in 1872, when the Ring was wide open, that it was impossible for me to doubt its reality; and, besides, it was verified at least on two occasions by Professor Winlock, the late director of the Harvard Observatory, who once was accompanied by Mr. Miliken, manager of the Western Union Telegraph Company, who also saw the dark angular forms on the following ansa.

Professor Hall seems to be in doubt as to the reality of the anomalous curvature of the shadow of the planet on the Ring, and appears inclined to attribute this appearance to some illusion caused by the varied conditions of our atmosphere. In reply, I will remark that, if such **was** the case, how could we explain its long duration as concave, and its no shorter duration as convex, which has been alternatively observed since the time of Cassini?

Several years ago, a very distinguished and industrious observer, F. Angelo Secchi of the Roman Observatory, pointed out that the deformation of the shadow of the Ball on the Ring was the natural consequence of the unevenness of the surface receiving it. If this is the true explanation, as I think it is, the natural consequence, as derived from the observations, is that the form of the surface is not permanent, since the shadow has evidently shown different outlines; appearing at different times either as a straight, a convex, a concave, or a notched line.

CAMBRIDGE, Oct. 5, 1877.